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THE CHICAGO DRAINAGE CANAL

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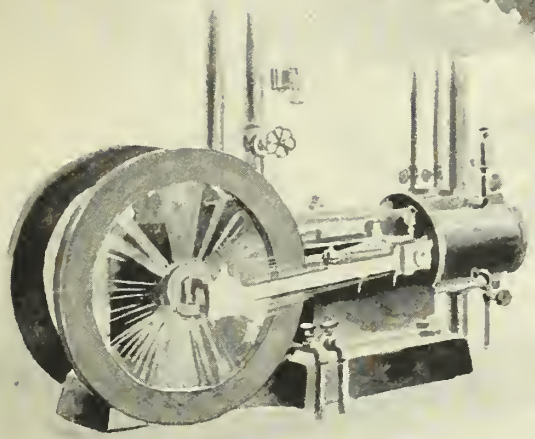

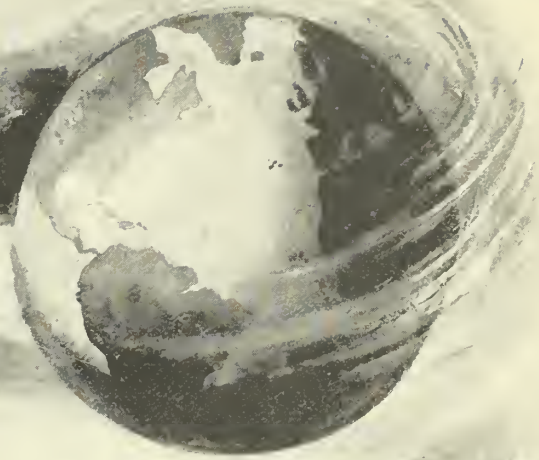

Compressed Air

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THE CHICAGO DRAINAGE CANAL.

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THE Chicago Main Drainage Canal, now nearing completion, is the most important piece of engineering work at present under construction. The canal will be for the purpose of relieving the city of Chicago, and a contiguous territory, known as the "Sanitary District of Chicago," of its sewage, and it is also to be used as a Ship Canal. The course of the canal is through the Desplaines Valley in a southwesterly direction, and extends from the South Branch of the Chicago River, at Robey Street, in Chicago, to Lockport, Will County, Illinois. At this point will be located "Controlling Works" for regulating the discharge, and the outflow, after passing through a tail-race to the Desplaines River at Joliet, follows this stream to the Illinois River and thence to the Mississippi.

Before constructing the Main Channel, it was necessary to control the Desplaines River, which, although an insignificant stream at ordinary stage, at flood times reaches a flow of 800,000 cubic feet per minute. This "River Diversion" work necessitated the excavation of 13 miles of artificial channel parallel to the Canal, and the building of 19 miles of levee from the spoil of both channels. This work was accomplished by an outlay of more than $1,000,000.

Through the rock divisions of the Canal, the specifications require that the side walls be formed by channels made in one to three cuts by Channeling Machines, and, where necessary, walls of masonry laid in cement will be built upon the rock surface to a height of five feet above low water level (1847) of Lake Michigan. Where the excavation is wholly through earth, the banks of the Canal have a two-to-one slope, no masonry being used. The grade in the rock sections is one foot in 20,000, and the Canal is designed for an ultimate flow of 600,000 cubic feet of water per minute, providing for a future population of 3,000,000 people.

The expense is to be borne by the people of the "Sanitary District," comprising all of the City of Chicago north of Eighty-seventh Street, together with some 43 square miles of Cook County directly benefited by the improvement. The population of the district is about 1,750,000.

Map of Sanitary District of Chicago.

ESTIMATED COST.

According to present estimates, it will cost $27,303,216 to complete the work, which, when finished, will be 35 miles in length, and will necessitate the removal of 39,972,762 cubic yards of material. In the "Rock Section" of the Canal, which is 160 feet wide and 35 feet deep, 12,071,668 cubic yards of material will be channeled, drilled, and blasted out of solid rock.

This is a brief outline of the gigantic enterprise, and the ambitious part that Ingersoll-Sergeant machinery took in carrying it out justifies the pride with which we present this little volume. It illustrates the progress being made on this important work, and incidentally includes some of the Ingersoll-Sergeant machinery in operation.

The latest summary made of the number of machines furnished to contractors and in use on the canal gives this result:

34 Ingersoll-Sergeant Channelers,
129 Ingersoll-Sergeant Rock Drills,
7 Ingersoll-Sergeant Air Compressors,

making in all 170 machines of the Ingersoll-Sergeant make.

INGERSOLL-SERGEANT AIR COMPRESSOR PLANTS ON THE CANAL.

	Contractors.
Section 1, one 18″ x 24″ Straight Line,	Griffiths & McDermott.
" 8, one 18″ x 20¼″ x 36″ Duplex Corliss,	Mason & King.
" 11, two 20″ x 24″ Straight Lines,	Mason, Hoge & King.
" 14, one 20″ x 20″ x 36″ Duplex Corliss,	Smith & Eastman.
" 14, one 16″ x 24″ Straight Line,	Smith & Eastman.
" 15, one 16″ x 16¼″ x 36″ Duplex Corliss,	Wright, Meysenberg, Sinclair & Carry.

961245

For Removing the Glacial Drift and Solid Rock the best devices known were brought into use. The machinery equipment employed during the Summer months included the following :

Steam shovels,	33	Cars,	900
Steam or air pumps,	85	Dredges,	27
Steam or air drills,	243	Grading machines	10
Steam or air hoists,	75	Steam towboats,	5
Channelers,	88	Dump scows,	17
Air compressors,	15	Conveyors of excavated material (including cantilevers, cableways, portable inclines, and derricks),	62
Locomotives,	27		

This outfit provided for the three divisions of work : Excavating earth or glacial drift, solid rock, and large deposits of alluvium and other semi-liquid matter. It is estimated that the work of excavation on the Chicago Canal is to be executed for less than one-half of the expense that the same work was done for on the Manchester Canal.

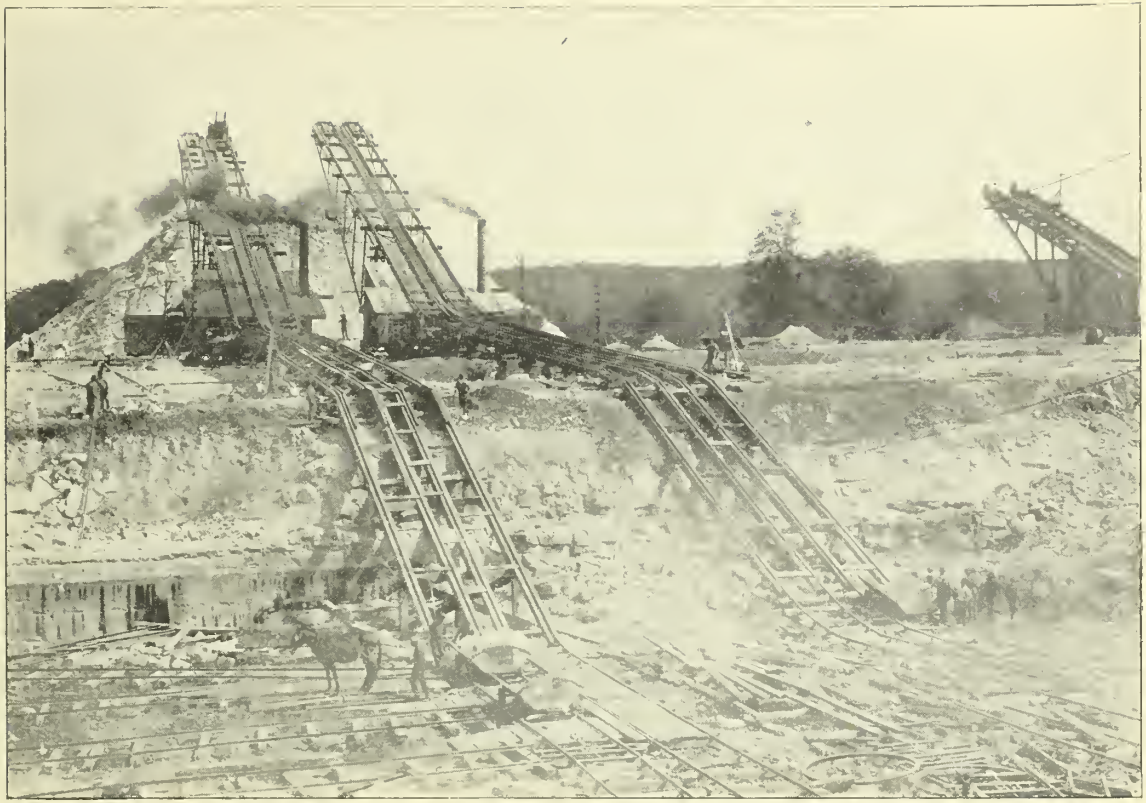
INGENIOUS CONTRIVANCES.

On account of sharp competition, the contracts were let at a low figure, and to realize a profit the contractors were obliged to employ every available means to cheapen the cost of excavation.

As an instance of the ingenuity displayed, we cite a few of the unique arrangements devised.

Mr. Jackson, of the contracting firm on section 10, first grasped the thought which, when developed, produced Brown's Cantilever Hoist, a balanced steel framed truss, 342 feet long, which reaches over the canal opening, and across a 50 foot berme and over a mountainous spoil bank, whose apex may be 90 feet above the ground. This machine, with clockwork precision, takes away about 600 cubic yards per day.

Another efficient device for handling the excavated materials is the Lidgerwood Traveling Cableway, also developed on this work. It consists of a main wire cable, suspended from two movable towers about 700 feet apart, and spanning the Canal, berme, and spoil bank. At the base of one of the towers is located the operating mechanism.



Tipple Inclines used on Rock Excavation, Section 1.

Griffiths & McDermott Construction Company, Contractors.

The load is supported from a carriage traveling on the main cable, and is controlled by smaller ropes leading to the engine. Five hundred cubic yards per day is the average work of this device.

The contractors on section 9 used a combination of portable derrick and movable incline, handling 500 cubic yards per day, and on section 14 a novel form of derrick, having two booms and carrying four skips, disposed of about the same quantity of material.

The lowest price on the "Ditch" for solid rock excavation is 59 cents per cubic yard. This is on section 15, where specially designed steam shovels load into cars the broken rock thrown out by the blast. Each shovel handles about 300 cubic yards per day.

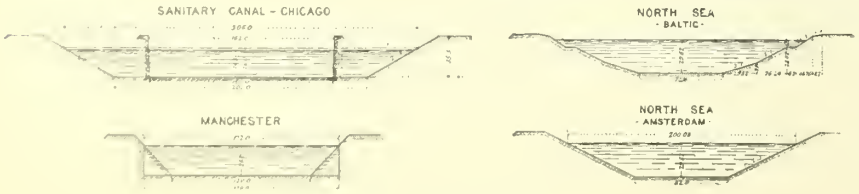
The alluvium deposit was removed by Hydraulic Dredges of different designs. The top soil was removed by the New Era Grader, which proved to be a simple and efficient device.

Air brakes and air dumping cars were used in connection with steam shovels.

On sections G and H the contractors adopted a new conveyor system. A steam shovel deposits into a granulator, which regularly feeds an endless belt. This is carried by a light steel frame attached to a long truss spanning the spoil bank. From it the stream of earth may be unloaded at any point by an adjustable plow.

Other contractors have devised an ingenious combination of steam shovel and movable incline. They dig the clay with exceptionally large shovel buckets, and deposit it into eight yard cars, which are hauled up by a cable and automatically dumped.

THE LARGEST CANAL IN THE WORLD.



COMPARATIVE SECTIONS OF CANALS

The cross sections of the Sanitary Canal are greater than either the Suez, the Manchester, or the North Sea ship canal.

The depth of 22 feet is for low water, while 26 feet is the depth at high water, and $24\frac{3}{10}$ the mean under ordinary conditions of the lake.

We are indebted to the *Engineering News* for courtesies extended in the compilation of this book.

Rock Drilling and Loading Broken Rock with Steam Shovel, on Section 15.

Wright, Meysenberg, Sinclair & Carry, Contractors.

THE NICARAGUA CANAL.

It has been predicted that the Drainage Canal, with the opportunities it has given for the study of canal making, has become an object lesson for the investing public who will undertake the next step in the world's progress, the building of the Nicaragua Canal. With the machinery used on the Chicago Canal, and the management imbued with the same energy, the channel connecting the Atlantic and Pacific by the Nicaragua route would soon be effected, and thus a grand dream of commerce would be realized.

COMPRESSED AIR.

One of the most conspicuous features of progress on the canal has been the application of compressed air for power purposes. Examples are notable in operation of extensive plants on the line of the canal, where powerful compressors force air at working pressure through main pipes one or two miles long on the canal bank, and distribute it to the rock drills. In several instances, advantage has been taken of its pressure to supply power to operate drainage pumps either in the place of or in addition to steam. There are also many instances where flexible connections are made to the main air pipe, and the pressure delivered to small hoisting engines that stand on the tail tower platform of the movable cableway machines, and pull them along the line by winding up on tackles anchored in advance.

Following the experience of the contractors on the Chicago Drainage Canal, and their connection with compressed air for distributing power to machinery for excavating purposes, it is worthy of note that Mr. J. B. McDonald, the contractor who was awarded the Jerome Park Reservoir contract in New York, has adopted the compressed air central plant system as being the most economical, efficient, and satisfactory of all methods. He has recently purchased of the Ingersoll-Sergeant Drill Company a complete plant of air compressing machinery to be installed on that work.

Another notable case is that of the Anaconda Mines in Montana. The plant comprises nine air compressors supplied by this company, and used to operate about 200 rock drills and for many other purposes.

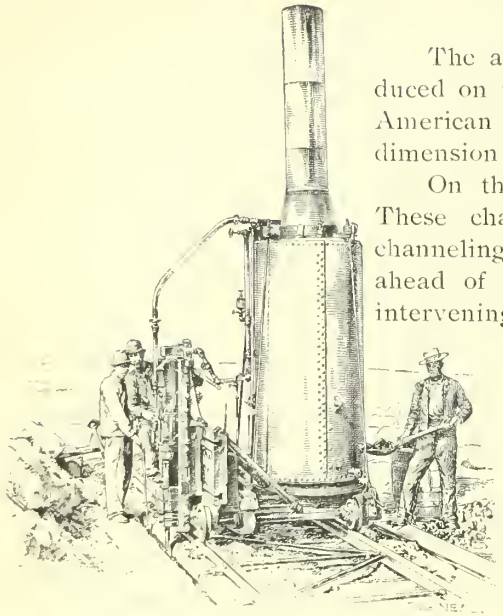
The Two Important Implements for Rock Excavation—Channeler and Drill—on Section 9.

Halverson, Richards & Co., Contractors. 7 Ingersoll-Sergeant Channelers. 18 Ingersoll-Sergeant Drills.

CHANNELING.

The application of the channeling process for canal construction was first introduced on the Chicago Drainage Canal. The channeling system is largely used in American stone quarries for the purpose of aiding the quarrymen in producing dimension stone in marketable shape, and in reducing the percentage of loss.

On the Chicago Drainage Canal, deep channels are cut on the boundary lines. These channels are about two inches in width, and are made as deep as the channeling machine will admit, that is, from 10 to 14 feet. The channeler runs ahead of the work of excavation, the cuts being made first, after which the intervening rock is broken by blasting in the usual way.



7-Inch Track Channeler at work on the Canal.

As the depth of the canal cut is about 35 feet, it was found necessary to make three distinct channels, one above the other, and each independent of the other, the offset being only about 8 inches. The advantage which the channeling process in canal construction gives, is a solid bank maintained free from irregularities and weaknesses produced by blasting. Were it not for the channeler, it would be necessary in many places to build up the bank of the canal by masonry or otherwise. The smooth wall made by the channeling machine facilitates the flow of water, lessening the friction. The excavation requires a slightly smaller amount of explosive because of the release lines made by the channel cut, and there is also an advantage in preventing the claims for extra work which might otherwise be made by the contractor, the rock on the canal being paid for between the channels. It is usual to put in a row of about 18 holes between the channels. These holes are about two inches in diameter and 12 feet deep, and are charged with 40% dynamite, and blasted simultaneously, throwing down the entire bench, and breaking it up into pieces varying in size from a brickbat to pieces of several tons weight.

Double Boom Derricks, and Rock Drilling, on Section 14.

19 Ingersoll-Sergeant Drills. 7 Ingersoll-Sergeant Channelers.

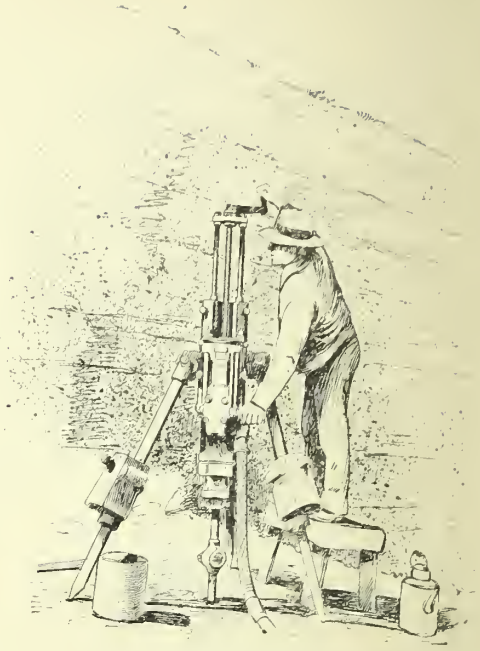
Smith & Eastman, Contractors. 1 20″ x 20¼″ x 36″ Ingersoll-Sergeant Duplex Corliss Compressor.

THE ROCK DRILL.

The Rock Drill is another application of improved machinery that promoted the work of rock excavation on the canal. The illustration printed on this page shows an Ingersoll-Sergeant Rock Drill at work. One hundred and twenty-nine drills of this make have been employed on the work up to date, many of the contractors using them exclusively.

Rock Drills are of inestimable value on works of this kind. They make possible within a short period commercial enterprises such as railroad tunnels, canals, bridges, buildings, and good roads.

While other projects of a similar nature were being talked of the Chicago Drainage Canal was completed, and the rock drill was one of the most potent factors to expedite the work.



"On the Bench."

A RECORD.

Lemont, Ill., Aug. 9, 1895.

The Ingersoll-Sergeant Drill Co., New York, N. Y.:

Dear Sirs: We have had in use on our work, Section 8, Chicago Drainage Canal, one of your 20 x 36 Air Cylinders, 18 x 36 Steam Cylinder Duplex Compressors, for more than one year, and have had no delay or stoppage on account of same during the whole time. It has given entire satisfaction. During the months of June and July, 1894, it did the drilling for the excavation of 147,085 cubic yards of solid rock, and furnished power for the pumps on two-thirds of the work, consuming only 333.4 tons of Illinois coal. Yours truly, MASON & KING,

By Robt. I. Mason.

Channeling Scene on Section 9.—Ingersoll-Sergeant Drills and Channelers were used exclusively on this Section.
Halverson, Richards & Co., Contractors.

Section 7.—GOOCH, RINEHART & CO., CONTRACTORS.

Using twelve (12) Ingersoll-Sergeant Drills; each drill makes a daily average of 70 lineal feet.

Two (2) McMiler Cantilevers, each employing 25 men to load buckets; each cantilever removes 300 yards of rock per day.

Two (2) McMiler Derricks; 25 men on each derrick to load buckets; each derrick removes 400 yards of rock per day.

One (1) Lidgerwood Cableway; 45 men to load buckets, nine (9) buckets; each cableway removes 500 yards of rock per day.

This section uses about 1½ pounds of powder to break two (2) yards rock, or ¾ pound powder per yard.

Section 9.—HALVERSON, RICHARDS & CO., CONTRACTORS.

Seven (7) Ingersoll-Sergeant Channelers made a daily average of 94 square feet for each machine, for seven months, channeling done on 1st, 2d and 3d lifts; all cuts 12 feet deep.

Fifteen (15) Ingersoll-Sergeant Drills made a daily average of 82 feet each, during the same period.

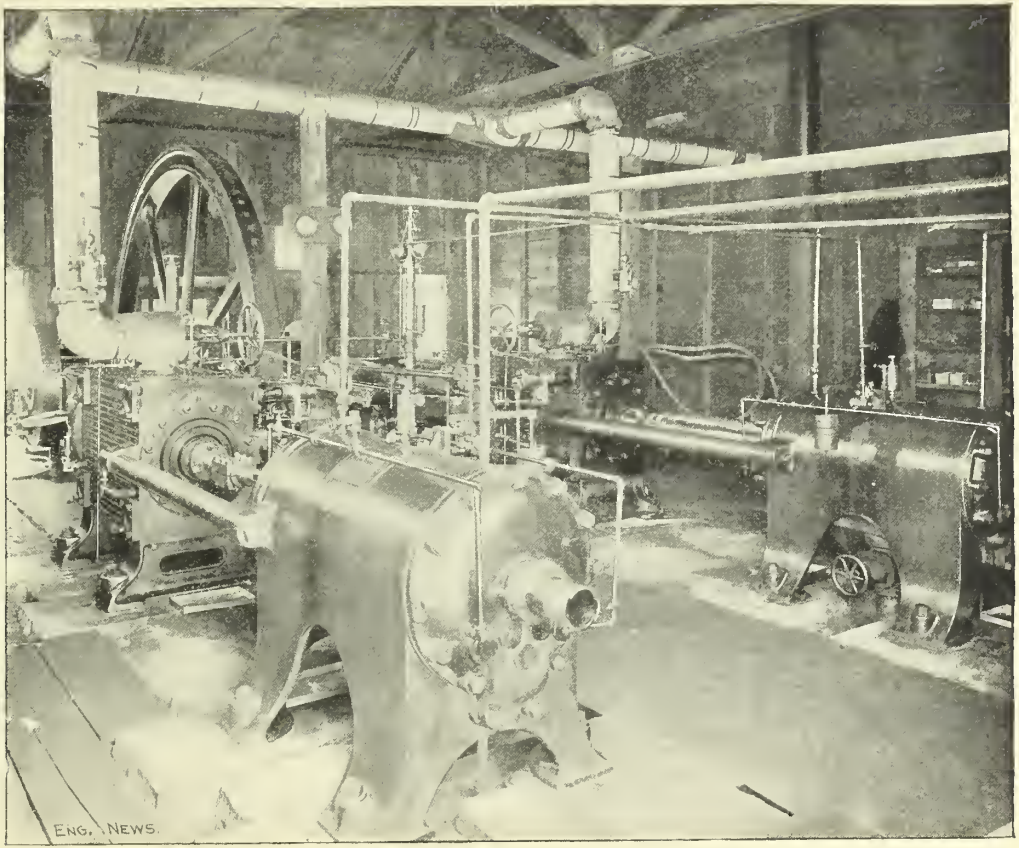
For six months, ending November 30, 1894, this section broke and removed 380,400 cubic yards of rock, or an average of 63,400 cubic yards of solid rock excavated per month. This makes a total of 191,880 lineal feet of holes for the six months, which is almost exactly two (2) cubic yards of rock excavated per one lineal foot of hole drilled.

Section 11.—ROSSER, COLEMAN & HOGE, CONTRACTORS.

Six (6) Ingersoll-Sergeant Drills, four of which are 3½ inch cylinder, and do all bench work. These four (4) drills, in from five to six hours, drill sixteen (16) twelve (12) foot holes in each bench.

Section 12.—MASON, HOGE & KING, CONTRACTORS.

Seven (7) Ingersoll-Sergeant Drills, working two benches, three drills on each bench, and one (1) drill block holing, put in eighteen (18) twelve (12) foot holes across the bench, or thirty-six (36) twelve (12) foot



INGERSOLL-SERGEANT 18 x 20¼ x 36 INCH DUPLEX CORLISS AIR COMPRESSOR PLANT, ON SECTION 8.

MASON & KING, Contractors.

holes in all. This work is done with six (6) 3½ inch drills in from six (6) to eight (8) hours. The holes are spaced eight feet (8') back from the face; 350 pounds of powder being used to make this blast on each breast.

The average output of rock per month broken on this section with the above drills is 25,000 to 30,000 cubic yards.

Two (2) Cantilevers; three men required to operate each cantilever, and 45 men employed loading the buckets. They remove an average of 300 buckets to each cantilever per day; 1¾ yards per bucket; averaging 25,000 yards per month.

Section 14.—SMITH & EASTMAN, CONTRACTORS.

Seven (7) Ingersoll-Sergeant Channelers have made a daily average of 110 square feet of channel on the 1st, 2d and 3d lifts. This includes all the time lost in moving, laying track, repairing, etc.; in fact, all the time for which the men who operate the machines are paid.

Nineteen (19) 3¼ inch "E 26" Sergeant Drills used on this section. They work their benches on the arc of a circle so as to bring the work under the swing of the derricks. The distance around this arc is 180 feet. In this they put in 27 twelve foot holes, using four (4) "E 26" drills on each bench; drilling the round of 27 holes 12 feet deep once each day. In 19 days, with four drills, they have broken 15,000 cubic yards of rock. The holes are put in eight feet from the face; 450 pounds of powder is used in blasting each face. It requires 45 men to load the buckets for each derrick, which will remove in ten hours steady work 500 yards of rock.

Section 15.—WRIGHT, MEYSENBERG, SINCLAIR & CARRY, CONTRACTORS.

In making the first opening along the west side of the "Ditch," they put in 48 twelve foot holes, on a surface of 30 feet by 40 feet, in six rows, eight holes in each row. This round of holes is put in each day with five 3½ inch Ingersoll-Sergeant Drills, each drill averaging 115⅓ lineal feet of holes per day. In blasting the above round of holes they use 650 pounds 40 per cent. Forcite Powder.

View of Brown Cantilever Crane, and Working Face in Rock Excavation.

INTERESTING NOTES.

As a record of costs in the consumption of fuel, and a guide for the estimates in excavating rock from the canal by means of improved machinery, we have a statement from Section 8, during the months of June and July of 1894, which is a fair example :

Cost of Illinois Bituminous coal delivered at compressor house, per ton,	$1.70
Amount of coal used,	333¼ tons
At a total cost of,	$566.78
Number of cubic yards of solid rock excavated during the same period,	147,085
The coal used per cubic yard excavated equaled a trifle more than	4½ pounds
Total amount of coal consumed at this plant from February 1 to June 30, 1895, was	1,538,250 pounds

On Section 9, for six months of 1894, the daily average of drills was 82 lineal feet. Seven channelers made and supplied by this company were also used. The daily average of the channelers for seven months of 1894 was 94 square feet for each machine. Channeling is the first work done after the surface soil is removed.

An elevation of 50 feet at Buffalo, or a depression of the same amount at Chicago, would reverse the drainage, and make the four upper lakes tributary to the Mississippi River.

There is five times as much rock excavation in this work as there was in the whole construction of the New Croton Aqueduct, 30 miles long.

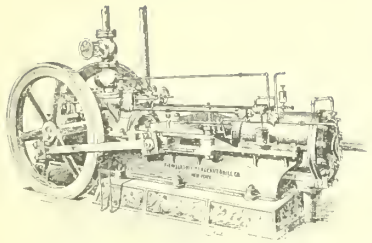
If the whole spoil bank of rock and earth from Chicago's great canal were used in building pyramids, a half dozen the size of Cheops would rise from the plain.

Comparing this canal with other great canals, we have, in round figures :

CANALS.	TOTAL EXCAVATION.	CANALS.	TOTAL EXCAVATION.
Chicago,	40,000,000	Suez Canal,	98,000,000
Corinth Ship Canal,	11,000,000	Panama Canal,	200,000,000
North Sea and Baltic Ship Canal,	67,000,000	Nicaragua Canal,	70,000,000
Manchester Ship Canal,	48,000,000		

Ingersoll-Sergeant Channeler, Section 14, Chicago Drainage Canal. Mr. Jobin, Superintendent, in the foreground.

THE MACHINERY, AND FORCE EMPLOYED.



The average consumption of dynamite on the entire line of the work amounted to eight (8) tons per day.

Regarding the number of men employed and the wages paid, we quote as follows from the report of the "Proceedings of the Board of Trustees" of August 28, 1895:

"Powerful machinery for digging and hoisting, steam shovels, excavators, inclines, conveyors, derricks, cantilevers, cableways, *channelers*, *steam drills*, pumps, etc., multiplied the effective productiveness of human labor, so that the contractors were encouraged to pay fair wages to their laborers, mechanics, and artisans. The men work by the hour, and are not hurried; there are always great numbers of laborers resting, and others take the vacant places in a sort of rotation, which requires as much as a threefold number of men from whom to fill the needed average working force for each day.

Machinery does the hardest work of digging and shoveling, and horse power is used in removing the top soil, more than 1,000 horses and mules being thus employed. The work done by hand in the rock sections is hard on men who are not used to it. The rock is blasted and then broken, so that it can be thrown into iron buckets, or loaded on trucks for removal. It requires strength, endurance, and some skill to handle the shattered rock of all sizes so as to avoid being hurt, or hurting somebody else through carelessness or lack of skill in moving the stuff. The work lasts ten hours during the day and eleven hours at night, but it is not as continuous and hurried as building operations in Chicago are conducted. The eight-hour law is nullified by the Supreme Court; the contractors could not arrange for three shifts, nor do the laborers ask for short work. The masses on the channel do not average fifty hours a week in the hard work of digging and loading in the rock and earth, and only a small proportion of the whole number of laborers keep at work every day of the week or month. They are not obliged to do so, and it is not their habit to work without interruption. Men may stop work at any time, get their wages, and after spending them go to work

again on some one of the twenty-nine sections of the Drainage Channel, and the number of those who work but part of the time is so large that, especially after pay-day, it is difficult to make up a full working force in the channel. This sort of transient workers corresponds with the floating population of some lodging-house localities in Chicago. Laborers of different nationalities work together in the same squad, and live peaceably in the same camp. There have been no race fights among them, and the wages of laborers are the same—American for each and all, namely: A minimum rate of 15 cents an hour for common labor, and fair wages for mechanics and engineers, according to the rates which are customary in and about Chicago. For Summer months the following working force was employed (more or less) on the channel by the contractors on all sections :

Superintendents	45	Channelers	113
Bookkeepers (including clerks)	32	Electricians	11
Foremen and Timekeepers	280	Machinists	37
Civil engineers	3	Stone masons	100
Steam shovel engineers	73	Carpenters	101
Crane men	73	Helpers	17
First lever men	12	Blacksmiths	69
Second lever men	8	Helpers	46
First hookers	12	Boilermakers	12
Second hookers	12	Helpers	7
Riggers	9	Oil man	1
Cableway repairers	7	Tool man	1
Engineers and pumpmen	240	Water men and boys	50
Firemen	275	Teamsters	450
Trainmen	50	Laborers	6,000
Drillers	210	Commissary employés	344

Making a grand total, 8,700 persons directly paid in the camps of the Drainage Channel.

The wages of one full working day of 8,245 men amounted to $14,150, being an average of $1.71 per man per day.

AUGUSTINE W. WRIGHT. O. W. MEYSENBERG. DONALD SINCLAIR. EDW. F. CARRY.

WRIGHT, MEYSENBERG, SINCLAIR & CARRY,

GENERAL CONTRACTORS.

LOCKPORT, ILL., December 3, 1895.

INGERSOLL-SERGEANT DRILL CO.:

GENTLEMEN: We had used your Rock Drills with such good results on our previous work that when we equipped our Chicago Drainage Canal contract we decided to employ your machinery exclusively.

We purchased of you a Duplex Corliss Air Compressor, together with a number of your Rock Drills and Channeling Machines; but, before we had ordered all of our drills, such extravagant statements were made to us regarding the performance and durability of another make of drill, that we decided to allow it to run in competition with yours, promising to buy it if it did more satisfactory work, and probably to use it instead of yours for our future requirements.

Although this drill was claimed to run with very much less air than the Ingersoll-Sergeant, the first thing asked for by the runner was 1¼" air hose. This we refused to furnish, as your drills were doing their work with 1" hose, and the test went on, both drills using the same size hose.

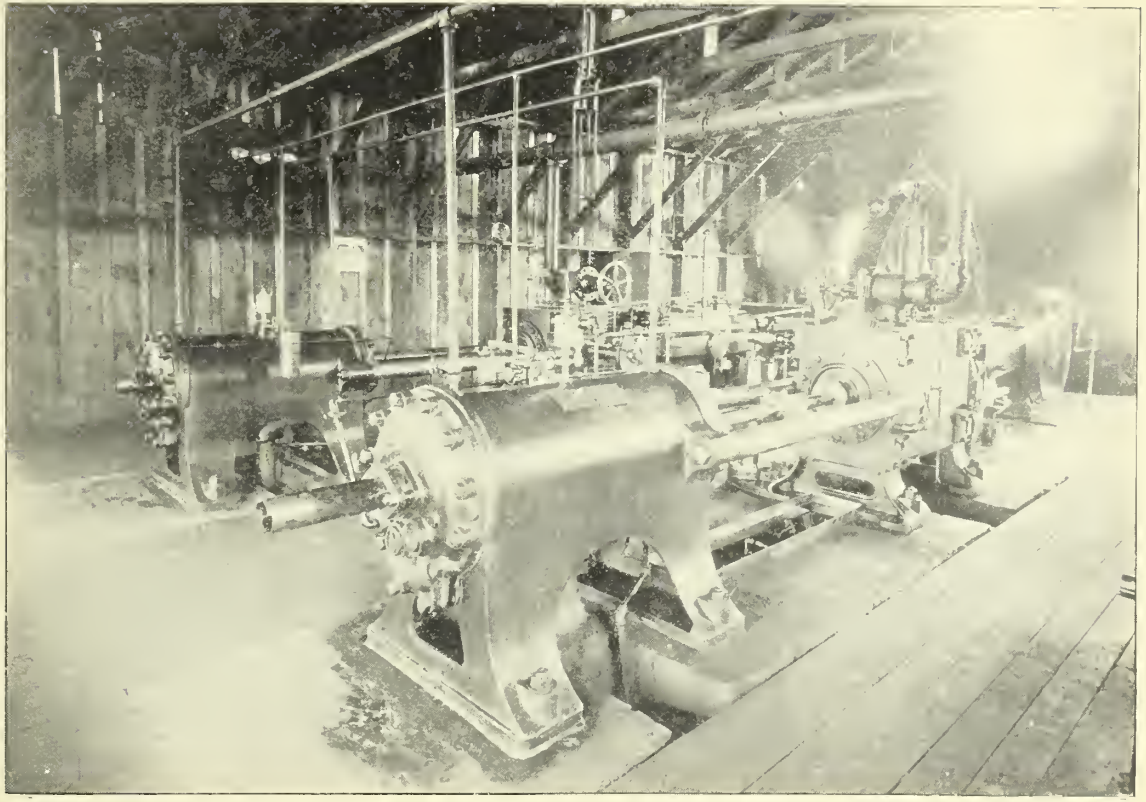
It is sufficient to state that on the test, which lasted about two weeks, your drill came out ahead, although the cylinder of the other drill was ⅛" larger diameter. As your drill did more work with less repairs than the other machine, all our orders placed since that time have been for Ingersoll-Sergeant Machines, which are the only drills in use in our contract. Yours truly,

WRIGHT, MEYSENBERG, SINCLAIR & CARRY.

D. SINCLAIR.

The test referred to was made last January. We give you below the record of the number of feet drilled by each machine on different days:

	INGERSOLL.	COMPETING DRILL.		INGERSOLL.	COMPETING DRILL.
January 16, 1895,	104 feet.	96 feet.	January 29, 1895,	123 feet.	129 feet.
" 17, 1895 (half day).	48 "	42 "	" 30, 1895,	97 "	108 "
" 18, 1895,	80 "	80 "	" 31, 1895,	96 "	90 "
" 19, 1895,	118 "	102 "	February 1, 1895,	136 "	106 "



Ingersoll-Sergeant 16 x 16¼ x 36 inch Duplex Corliss Air Compressor Plant, Section 15.

Wright, Meysenberg, Sinclair & Carry Contractors.

CONTRACTORS' PRICES PER CUBIC YARD, AND AMOUNT OF EXCAVATION.

SHOWING NUMBER OF INGERSOLL-SERGEANT CHANNELING MACHINES AND ROCK DRILLS ON EACH SECTION.

SECTION.	NAME OF CONTRACTORS.	INGERSOLL-SERGEANT MACHINERY.		AMOUNT SOLID ROCK EXCAVATION.	CONTRACT PRICE. SOLID ROCK.
		CHANNELERS.	DRILLS.		
1	Griffiths & McDermott,	1	5	536,024 cubic yards.	80c. per cubic yard.
2	McArthur Brothers,	1	6	472,624 " "	80c. " " "
4	McArthur Brothers,	1	10	359,677 " "	80c. " " "
5	Qualey Construction Company,		1		
6	Mason, Hoge, King & Company,	3	3	531,261 " "	72½c. " " "
7	Gooch, Rinehart & Company,	4	12	888,219 " "	72½c. " " "
7	E. L. Smith,		4		
8	Mason & King,	5		1,163,315 " "	74¾c. " " "
9	Halverson, Richards & Company,	7	18	1,005,416 " "	76.9c. " " "
11	Rosser, Coleman & Hoge,		6	942,907 " "	79¼c. " " "
11	Locker, Harder & Williamson,	1	9		
12	Mason, Hoge & King,	1	11	1,000,500 " "	73c. " " "
12	William Bruce,		2		
12 and 13	Dandridge & Hanger,		2	1,053,700 " "	74¾c. " " "
13	Woolfolk, Johnson & Comer,		5		
13	Garden Brothers & Smith,		1		
14	Smith & Eastman,	7	19	1,023,500 " "	73c. " " "
15	Wright, Meysenberg, Sinclair & Carry,	3	15	639,700 " "	59c. " " "
		34	129		

The work began September 3, 1892, and contracts for completion expire April 30, 1896. The rock formation first appeared in sections 3 and 4. It then disappeared, and on section 6 it began again, and for a distance of 9 miles is a continuous stratum of rock.

McMiler Derricks and Portable Inclines, Section 9.—Ingersoll-Sergeant Machinery used exclusively on this Section.

Halverson, Richards & Co., Contractors.

OFFICE OF

SMITH & EASTMAN.

302 First National Bank Building,
Monroe and Dearborn Sts.

Chicago, December 5, 1895.

The Ingersoll-Sergeant Drill Co., Chicago, Ill.:

Gentlemen: We have about completed the excavation of Section 14 of the Chicago Drainage Canal, and, as we have used your machinery entirely on this contract, we feel it our duty to give you a statement of the satisfactory work it has done for us.

Our rock excavating plant includes the following Ingersoll-Sergeant machinery:

1 Duplex Corliss Air Compressor, size 20" x 20¼" x 36".
7 Channeling Machines.
19 Rock Drills.

In addition to the Rock Drills, we are running, by compressed air, seven (7) pumps and three (3) blacksmith forges.

For the seven (7) months ending October 31, 1895, our output was 480,700 cubic yards of solid rock, making an average of 68,700 cubic yards per month, and during the months of April and May, 1895, we took out 167,900 cubic yards of solid rock, to remove which it was necessary to cut about 56,000 square feet of channel and drill about 84,000 lineal feet of holes.

We are very glad to express our appreciation of the good work done by your machinery, and of the courteous treatment received from your company.

Yours, respectfully,

SMITH & EASTMAN.

Extract from proceedings of the Board of Trustees, Sanitary District of Chicago, June 26, 1895:

"Sec. 14. The output of 86,400 cubic yards of solid rock in April, followed by one of 81,500 cubic yards for May, an aggregate of 167,900—*an achievement unparalleled in rock excavation* from a single mile section."

View showing Method of Rock Excavation by Dump Cars and Cable Inclines, Section 10.

TABLES SHOWING COST OF OPERATING CHANNELERS.

SHOWING WORK OF FIVE INGERSOLL-SERGEANT CHANNELERS ON SECTION 8, AND COST OF OPERATING THE SAME PER DAY, DURING THE MONTH OF MAY, 1894.

DATE	CHANNELER NO. 1		CHANNELER NO. 2.		CHANNELER NO. 3.		CHANNELER NO. 4.		CHANNELER NO. 5.	
	Sq. ft.	Cost.	Sq. ft.	Cost.	Sq. ft.	Cost.	Sq. ft.	Cost.	Sq. ft.	Cost.
1	135	$11.25	50	$10.00	113	$10.00	122	$11.25	150	$8.75
2	133	11.25	118	8.75	75	8.75	137	8 75	175	8.75
3	140	6.85	75	6.85	75	6.85	111	6.85	140	6.85
4	180	8.75	75	8.75	112	8.75	146	8.50	175	8.75
5	113	8.75	125	6.25	50	6.25	52	8.75	140	6.25
6	Sunday	.87	Sunday	.87	Sunday	.87	Sunday	.87	Sunday	.87
7	170	8.75	119	6.25	75	5.10	120	11.25	100	8.75
8	150	11.25	112	6.25	50	8.75	135	5 00	140	6.25
9	200	8.75	100	8.75	50	11.25	50	2.50	. .	7.10
10	150	8.13	112	2.70	70	4.65	....	5.00	100	7.66
11	150	8.75	125	6.50	90	10.65	....	6.25	175	8.75
12	220	8.75	50	8.25	112	11.25	..	6.25	140	11.25
13	Sunday	.87	Sunday	.87	Sunday	.87	Sunday	.87	Sunday	.87
14	125	8.75	75	8.87	40	6.25	40	6.25	160	8.75
15	200	8.75	100	6.25	60	8.75	155	8.75	20	2.50
16	150	11.25	87	6.25	50	8 75	134	11.25	180	8.75
17	100	5.62	87	8.75	50	8.75	155	5.62	140	8.75
18	75	8.75	150	5.62	50	5.37	190	8.75	65	5.62
19	..	4.95	100	8.87	40	6.25	105	8.75	175	11.25
20	Sunday	3.57	Sunday	1.50	Sunday	.87	Sunday	.87	Sunday	.87
21	175	8.75	100	9.75	....	8.75	145	9.25	150	8.75
22	100	13.75	112	9.75	...	8.75	190	13.75	160	6.25
23	180	6.25	60	6.25	87	6.25	180	6.25	125	6.25
24	200	11.25	....	9.50	140	11.25	175	11.25	175	11.25
25	175	8.75	100	8.75	85	11.25	221	11.25	150	8.75
26	200	8 75	150	8.75	140	8.75	153	8.75	65	8.75
27	Sunday	.87	Sunday	.87	Sunday	.87	Sunday	.87	Sunday	.87
28	170	8.75	50	11 25	157	8.75	200	11.25	122	7.50
29	125	8.75	112	6.25	105	11.25	141	11.25	160	5.50
30	150	8.75	112	11.25	120	8.75	143	8.75	...	. ..
31	145	8.75	100	11.25	210	6.25	125	10.00	....	5.50
Total	4,020	$247.98	2,556	$220.77	2,206	$229.85	3,325	$234.95	3,291	$206.71

Total cost of blacksmithing, oil, hauling, and machinist in charge of five channelers for 31 days, $205.60.

SHOWING WORK DONE BY INGERSOLL-SERGEANT CHANNELER NO. 1 ON SECTION 8, AND THE COST OF OPERATING THE SAME PER DAY, FOR THE MONTH OF MAY, 1894.

DATE.	SQ. FT.	RUNNER.	HELPER	FIREMAN.	COAL.	TOTAL.
1	135	$3.00	$1.50	$1.75	$5.00	$11.25
2	133	3.00	1.50	1.75	5.00	11.25
3	140	2.10	1.05	1.20	2.50	6.85
4	180	3.00	1 50	1.75	2.50	8.75
5	113	3.00	1.50	1.75	2.50	8.75
6	Sunday	....	...	.87	....	.87
7	170	3.00	1.50	1.75	2.50	8.75
8	150	3.00	1.50	1.75	5.00	11.25
9	200	3.00	1.50	1.75	2.50	8.75
10	150	2.70	1.35	1.58	2.50	8.13
11	150	3.00	1.50	1.75	2.50	8.75
12	220	3.00	1.50	1.75	2.50	8.75
13	Sunday	.	...	.87	...	.87
14	125	3.00	1.50	1.75	2.50	8.75
15	200	3.00	1.50	1.75	2.50	8.75
16	150	3.00	1.50	1.75	5.00	11.25
17	100	1.50	.75	.87	2.50	5.62
18	75	3.00	1.50	1.75	2.50	8.75
19	..	3.00	.75	1.20	....	4.95
20	Sunday	1.80	.90	.87	....	3.57
21	175	3.00	1.50	1.75	2.50	8.75
22	100	3.00	1.50	1.75	7.50	13.75
23	180	3.00	1.50	1.75	...	6.25
24	200	3.00	1.50	1.75	5.00	11.25
25	175	3.00	1.50	1.75	2.50	8.75
26	200	3.00	1.50	1.75	2.50	8.75
27	Sunday	...	. .	.87	....	.87
28	170	3.00	1.50	1.75	2.50	8.75
29	125	3.00	1.50	1.75	2.50	8.75
30	150	3.00	1.50	1.75	2.50	8.75
31	145	3 00	1.50	1.75	2.50	8.75
Total	4,020	$80.10	$39.30	$48.58	$80.00	$247.98

Cost for blacksmithing, oil, hauling, and machinist in charge, $43.13.

Completed Rock Cut.—Lidgerwood Traveling Cableway, Section 8.

Mason & King, Contractors.

WAGES PAID ON THE CANAL.

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The average wages on the Drainage Channel are as follows :

DAILY WAGES :

Laborers	$1.50	to	$1.75	Second hookers	$1.50		
Teamsters	1.50	"	1.60	Riggers	2.25		
Drillers	1.75	"	2.00	Cableway repairers	2.25		
Trainmen	1.75	"	2.00	Machinists	2.00	to	$2.50
Firemen	1.75			Carpenters	2.00	"	2.25
Channelers	2.50	"	3.00	Blacksmiths	2.50	"	3.00
First lever men	2.20			Boilermakers	3.50		
Second lever men	1.50			Stonemasons	3.50	"	4.00
First hookers	1.75						

MONTHLY WAGES :

Superintendents	$100.00	to	$150.00	Electricians	$75.00	to	$90.00
Timekeepers	50.00	"	100.00	Civil engineers	90.00	"	100.00
Bookkeepers and clerks	60.00	"	125.00	Steam shovel engineers	125.00		
Foremen	60.00	"	80.00	Crane men	90.00	"	100.00
Engineers and pumpmen	50.00	"	80.00				

These figures show that various kinds of skill are paid different rates of wages, and the skilled mechanics are mostly hired by the month.

Offices of the Ingersoll-Sergeant Drill Co.

CHICAGO, Old Colony Building.
CLEVELAND, Ohio, 26 S. Water Street.
BOSTON, Mass., 201 Congress Street.
ST. LOUIS, Mo., 715 North 2d Street.
BIRMINGHAM, Ala., 1921 Powell Street.
DENVER, Colo., 1718 California Street.
SAN FRANCISCO, Cal., 21 Fremont Street.
SALT LAKE CITY, Utah, 259 Main Street.
BUTTE, Mont., 300 Main Street.
MONTREAL, Can., 164 St. James Street.
MEXICO, Calle de Cadena, No. 17.
LONDON, Eng., 114a Queen Victoria Street.
SYDNEY, Aust., 187 Clarence Street.
JOHANNESBURG, So. Africa, Box 1809.
VALPARAISO, Chili.

The Ingersoll-Sergeant Drill Co.

Gaylord Bros. Inc.
Makers
Syracuse, N. Y.

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